ADDRESSING THE IMPACT OF FRACTURE DURING INDENTATION OF MOLECULAR CRYSTALS

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There are inherent challenges in mechanical testing of anisotropic molecular crystals, one of which being their propensity for brittle fracture, which can limit the usage conditions of the material as well as the range of conditions in which mechanical testing results are valid. Molecular crystals, which contain the families of many energetic materials and pharmaceutical materials (in addition to ice), are commonly considered to be both compliant and brittle, and in most common forms the materials are used as small crystalline powders suspended in binders rather than in pure polycrystalline aggregates. Indentation testing on molecular crystals has previously been shown to be able to quantify modulus, hardness, and yield points in materials ranging from sucrose [1] to energetics and pharmaceuticals [2], [3]. To quantify the fracture response in materials that cannot be subjected to traditional toughness tests due to limited particle size and morphology, a technique is used in which nanoindentation tests are performed on a material with probes of varying acuity, and analysis of the unloading portion of the resulting load-depth curve indicates presence or lack thereof of radial cracking [4]. This technique has been used to define a radial cracking threshold for the secondary explosives HMX (cyclotetramethylenetetranitramine) and PETN (pentaerythritol tetranitrate) of 4 mN as well as a cracking threshold beginning at 100 mN for the pharmaceutical idoxuridine. The low indentation fracture toughness in the explosives may be the reason for difficulty that has been seen previously in accurately obtaining mechanical property measurements over a wide range of depths in these materials.

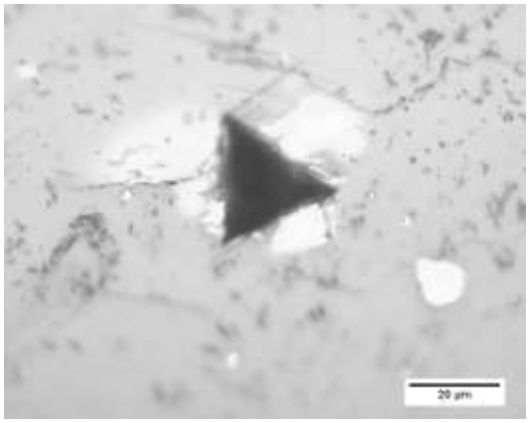

Figure 1 -- Indentation fracture in idoxuridine

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